Biohydrometallurgy for Cobalt and Nickel recovery from laterites: project BioProLat

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Background

Laterite ore deposits in Brazil and other tropical countries contain approximately 70% of the world's Ni, and Co resources, as well as other critical raw materials of commercial importance. High energy and/or reagent costs, accompanied by expensive equipment costs, are generally incurred when recovering Ni and Co via pyro- or hydrometallurgy.

Fig. 1: Laterites in the mine Barro Alto (Anglo American), federal state Goiás, Brazil. Left: Fresh limonite. Right: Stockpile. Source: BGR.

Considering economic efficiency, the **development of an integrated low-energy and environmentally benign biohydrometallurgical process for the recovery of Ni and Co from laterite ores in Brazil** is the aim of the German-Brazilian project BioProLat.

Material & Methods

On laboratory scale, 2L bioreactor experiments with 10% (w/v) laterite stockpile sample, addition of elemental sulfur and a consortium of six *Acidithiobacillus thiooxidans* bacterial strains were conducted. Bioleaching was performed under aerobic conditions at 30 °C and pH 1.5 or uncontrolled pH under constant stirring. Leaching without addition of bacteria served as control.

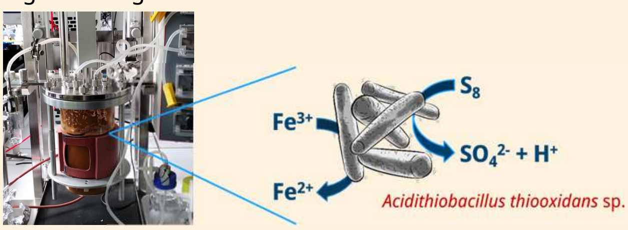


Fig. 2: Acidophilic bacteria reduce insoluble metal compounds to a water-soluble form at low pH, by using S as electron donor and coupling S oxidation to Fe^{3+} reduction. Thereby H_2SO_4 is generated, which keeps an acidic milieu and iron in solution.

Sample characterization was done by using XRF, XRD and SEM-MLA. Metal ions in solution were determined by ICP-OES or by photometry. Cells were counted via fluorescence microscopy.

Results (selected) & Outlook

Bioleaching with the *A. thiooxidans* consortium resulted in higher concentrations of metals in solution than in the abiotic chemcial leaching control after 15 days of leaching (Fig. 3).

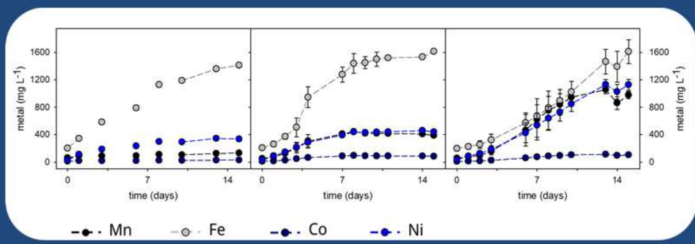


Fig. 3: Metals in solution during leaching over 15 days (left: abiotic control, pH 1.5, n = 1; middle: bioleaching, pH 1.5, n = 2; right: bioleaching, pH not controlled, n = 4).

The leaching degree of **Ni** and **Co** after **bioleaching** accounted for **32%** and **67% at pH 1.5**, respectively and for **83% for both when pH was not controlled** (Fig. 4). **Bioleaching of Ni and Co at uncontrolled pH** resulted in **2.6 and 1.2 times higher** leaching degrees, respectively, **compared to bioleaching at pH 1.5**.

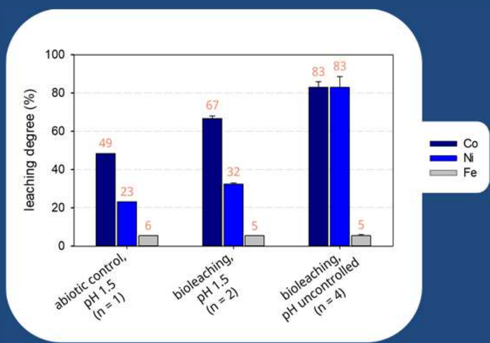
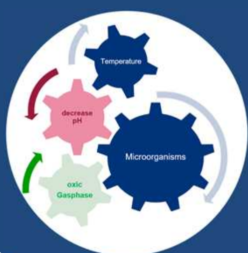


Fig. 4: Leaching degrees after 15 days of leaching.

Bioleaching is under optimization for other laterite ore samples. Eventually, the optimized process will be up- scaled and reach pilot scale:



- Transforming unexploited ores and limonite stockpiles into valuable resources
- Unlocking new reserves of raw materials through increasing recovery of metals from existing mines

Acknowledgements

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For more information on the project visit